

What is claimed is:

1. A magnetic memory comprising a plurality of memory cells, each memory cell including : at least one writing wire; at least one data storage portion, provided on at least one portion of an outer periphery of the writing wire, which comprises a ferromagnetic material whose magnetization direction can be inverted by causing a current to flow in the writing wire; and at least one magneto-resistance effect element, disposed in the vicinity of the data storage portion, which senses the magnetization direction of the data storage portion.
2. The magnetic memory according to claim 1, wherein each memory cell is provided with a writing selection transistor which is connected at one of a source and a drain thereof to the writing wire.
3. The magnetic memory according to claim 2, further comprising a plurality of common bit lines and cell bit lines, each of cell bit lines being branched from each common bit line for each memory cell, the data storage portion being provided at least one portion of an outer periphery of the cell bit line, the magneto-resistance effect element being disposed in the vicinity of the data storage portion and the cell bit line functioning as the writing wire.
4. The magnetic memory according to claim 3, wherein the data storage portion is provided so as to surround at least three directions of four directions of the outer periphery of the writing wire, the magneto-resistance effect element is disposed in the remaining one direction of the outer periphery, the magnetization direction of the data storage portion is substantially parallel to a circumferential direction of the writing

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Related Pending Application

Related Case Serial No: 10/696,000

Related Case Filing Date: 10-30-03

wire, and the magnetization direction appearing at both ends of the data storage portion is sensed by the magneto-resistance effect element.

5. The magnetic memory according to claim 3, wherein the data storage portion is provided so as to surround four directions of the outer periphery of the writing wire, the magneto-resistance effect element is provided so as to correspond to one direction of the four directions, and the data storage portion and a magnetization free layer of the magneto-resistance effect element are magnetically coupled.

6. The magnetic memory according to claim 3, wherein a magnetization free layer of the magneto-resistance effect element contacts with the data storage portion.

7. The magnetic memory according to claim 3, further comprising a sense assist wire which is provided in the vicinity of the magneto-resistance effect element and generates a magnetic field due to a current flowing therein and which assists sensing of the magnetization direction of the data storage portion.

8. The magnetic memory according to claim 3, further comprising a write assist line which is provided in the vicinity of the data storage portion so as to be substantially perpendicular to the cell bit line and generates a magnetic field in a direction perpendicular to the magnetization direction of the data storage portion.

9. The magnetic memory according to claim 3, wherein the cell bit line has a first wiring portion which is branched from a corresponding one of the common bit lines, a second wiring portion which is provided along a

side portion of the magneto-resistance effect element via an insulating film and has one end connected to the first wiring portion, and a third wiring portion which has one end connected to the other end of the second wiring portion and is provided substantially in parallel with the first wiring portion such that the third wiring portion and the first wiring portion sandwich the magneto-resistance effect element, and

wherein the magneto-resistance effect element is electrically connected to one of the first wiring portion and the third wiring portion, the data storage portion has a first storage portion provided on an outer peripheral portion of the first wiring portion and a second storage portion provided on an outer peripheral portion of the third wiring portion, and the magneto-resistance effect element is provided in the vicinity of the first storage portion and in the vicinity of the second storage portion.

10. The magnetic memory according to claim 3, wherein

the cell bit line comprises a first wiring portion, a second wiring portion, and a third wiring portion, the first wiring portion being branched from a corresponding one of the common bit lines and electrically connected to a first magneto-resistance effect element, the second wiring portion being provided along a side portion of the first magneto-resistance effect element via an insulating film and having one end connected to the first wiring portion, and the third wiring portion having one end connected to the other end of the second wiring portion, being provided substantially in parallel with the first wiring portion and being electrically connected with a second magneto-resistance effect element,

the data storage portion has a first storage portion

and a second storage portion, the first storage portion provided on an outer peripheral portion of the first wiring portion and the second storage portion provided on an outer peripheral portion of the third wiring portion, and

the first magneto-resistance effect element is provided in the vicinity of the first storage portion and the second magneto-resistance effect element is provided in the vicinity of the second storage portion.

11. The magnetic memory according to claim 10, further comprising a differential amplifier which reads outputs of the first and second magneto-resistance effect element in a differential manner.

12. The magnetic memory according to claim 3, wherein each memory cell is caused to correspond to first and second common bit lines, the cell bit line has a first wiring portion which is branched from the first common bit line to be electrically connected with the magneto-resistance effect element and a second wiring portion which is branched from the second common bit line and has a portion provided substantially in parallel with the first wiring portion such that the first wiring portion and the second wiring portion sandwich the magneto-resistance effect element, the data storage portion comprises a first and second data storage portions, the magneto-resistance effect element is provided in the vicinity of the first storage portion and in the vicinity of the second storage portion, the magneto-resistance effect element has a magnetization fixed layer in which magnetization direction has been fixed and a magnetization free layer which senses the magnetization directions of the first storage portion and the second storage portion, and a magnetization easy axis of the magnetization fixed layer and a

magnetization easy axis of the magnetization free layer are substantially perpendicular to each other.

13. A magnetic element comprising: a writing wire and a magneto-resistance effect element, the magneto-resistance effect element including at least one magnetization free layer which covers an outer periphery of the writing wire and comprises a ferromagnetic material whose magnetization direction can be inverted by causing a current to flow in the writing wire; and a stack film, the stack film comprising a magnetization fixed layer; a tunnel barrier layer sandwiched between the magnetization free layer and the magnetization fixed layer; and an anti-ferromagnetic layer provided on one side of the magnetization fixed layer opposite from the tunnel barrier layer.

14. A magnetic element according to claim 13, wherein the magnetization fixed layer is provided with a first ferromagnetic layer, a second ferromagnetic layer, and a non-magnetic layer sandwiched between the first ferromagnetic layer and the second ferromagnetic layer.

15. A magnetic element comprising: a writing wire and a magneto-resistance effect element, the magneto-resistance effect element including at least one magnetization free layer which covers an outer periphery of the writing wire and comprises a ferromagnetic material whose magnetization direction can be inverted by causing a current to flow in the writing wire; and a first and second stack films, the first stack film comprising a first magnetization fixed layer provided on one side of the writing wire via the magnetization free layer; a first tunnel barrier layer provided between the magnetization free layer and the first magnetization fixed layer; and a first anti-ferromagnetic layer

provided on one side of the first magnetization fixed layer opposite from the first tunnel barrier layer, the second stack film comprising a second magnetization fixed layer provided on the other side of the writing wire via the magnetization free layer; a second tunnel barrier layer provided between the magnetization free layer and the second magnetization fixed layer; and a second anti-ferromagnetic layer provided on one side of the second magnetization fixed layer opposite from the second tunnel barrier layer.

16. A magnetic element according to claim 15, wherein one of the first and second magnetization fixed layers is provided with a first ferromagnetic layer, a second ferromagnetic layer, and a non-magnetic layer sandwiched between the first ferromagnetic layer and the second ferromagnetic layer.

17. A magnetic memory comprising a plurality of memory cells, each memory cell having a magnetic element according to claim 13.

18. A magnetic memory comprising a plurality of memory cells, each memory cell having a magnetic element according to claim 14.

19. A magnetic memory comprising a plurality of memory cells, each memory cell having a magnetic element according to claim 15.

20. A magnetic memory comprising a plurality of memory cells, each memory cell having a magnetic element according to claim 16.

ABSTRACT OF THE DISCLOSURE

The magnetic memory includes a plurality of memory cells, each memory cell including: at least one writing
5 wire; at least one data storage portion, provided on at least one portion of an outer periphery of the writing wire, which comprises a ferromagnetic material whose magnetization direction can be inverted by causing a current to flow in the writing wire; and at least one
10 magneto-resistance effect element, disposed in the vicinity of the data storage portion, which senses the magnetization direction of the data storage portion.

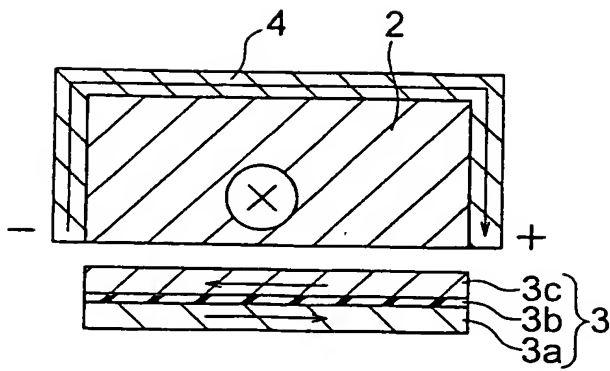


FIG. 1A

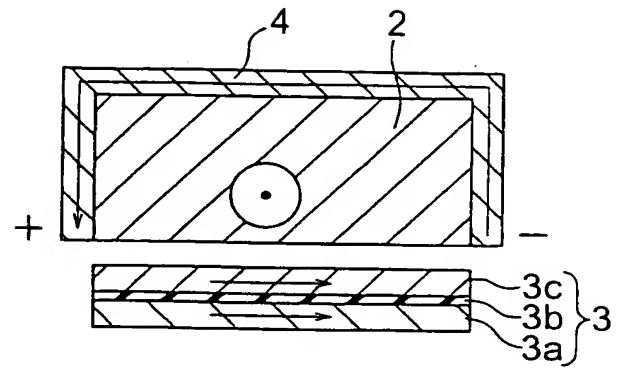


FIG. 1B

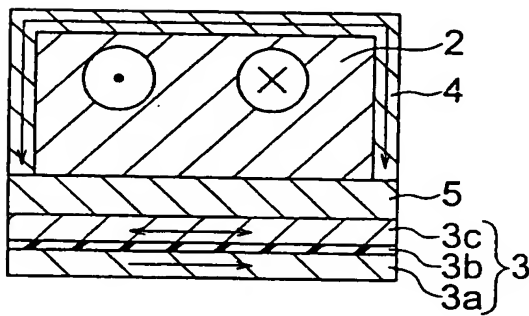


FIG. 2A

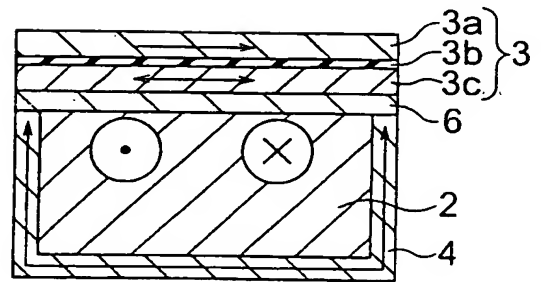


FIG. 2B

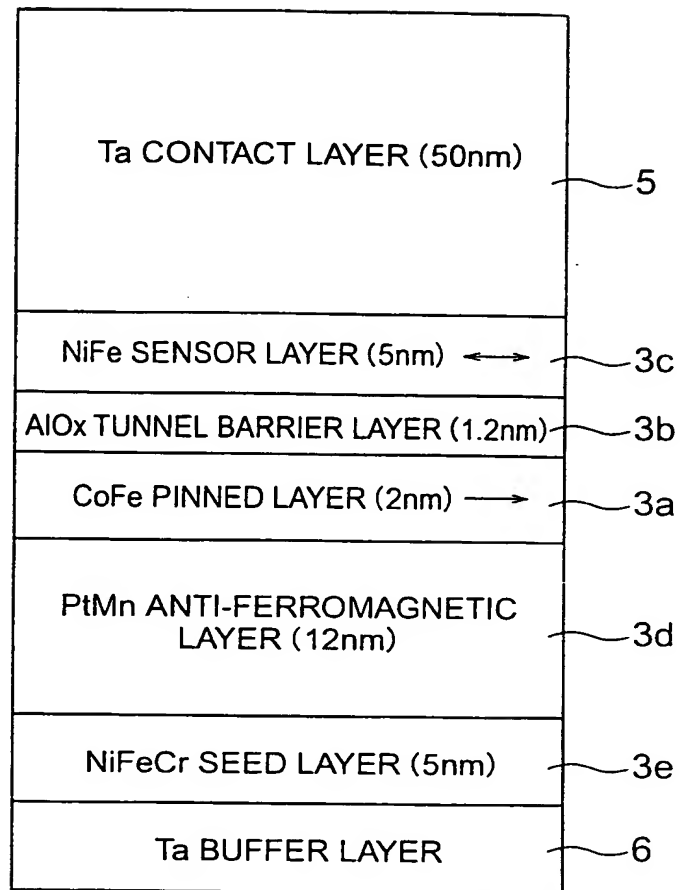


FIG. 3

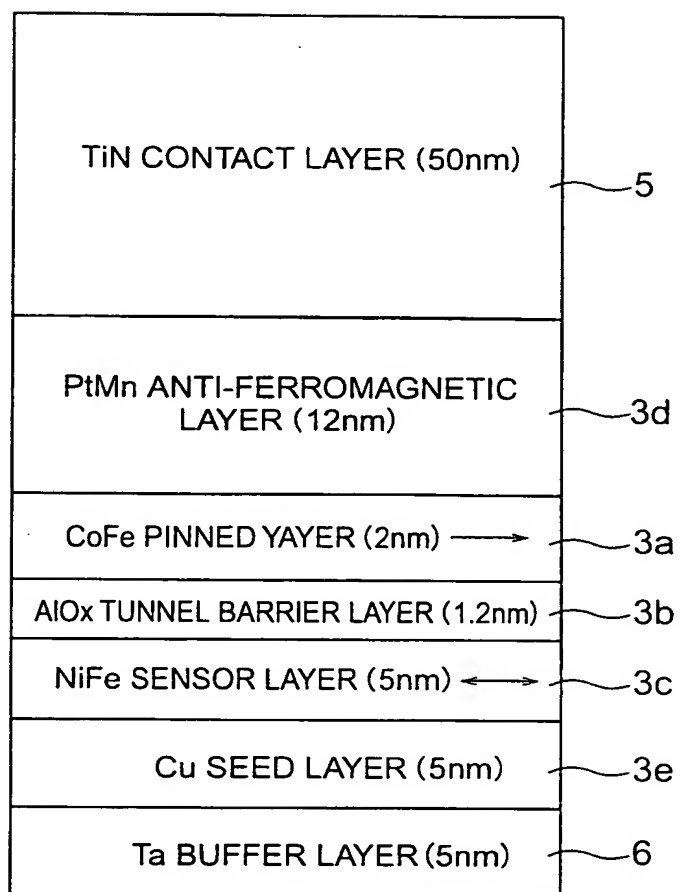


FIG. 4

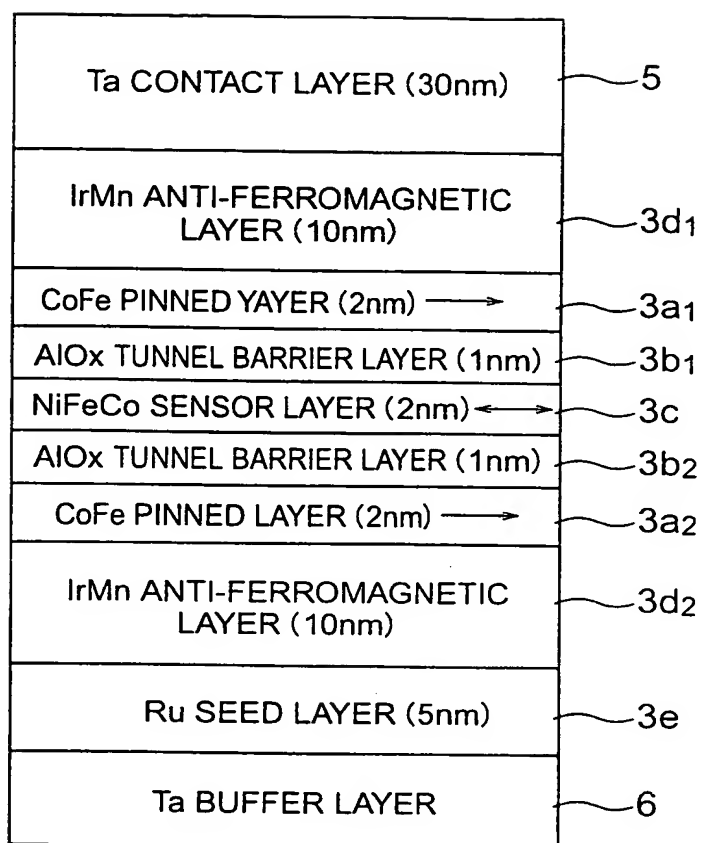


FIG. 5

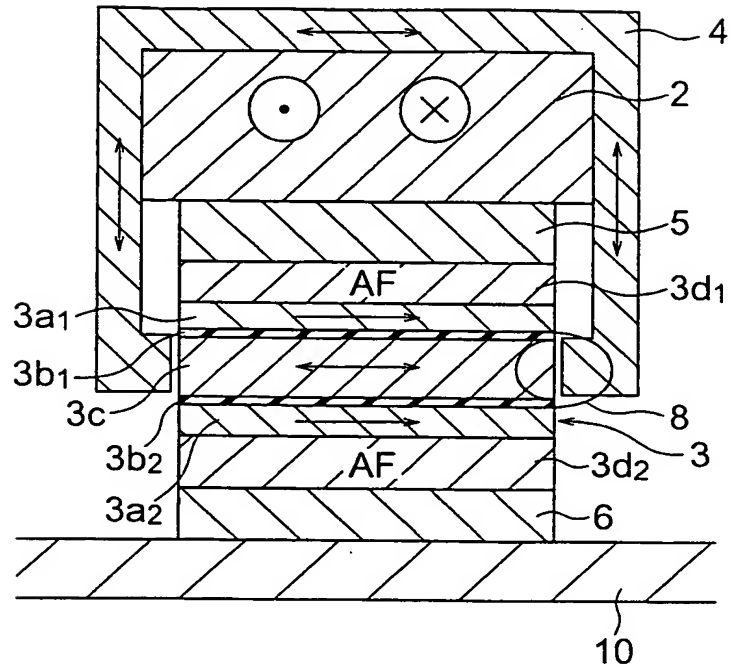


FIG. 6

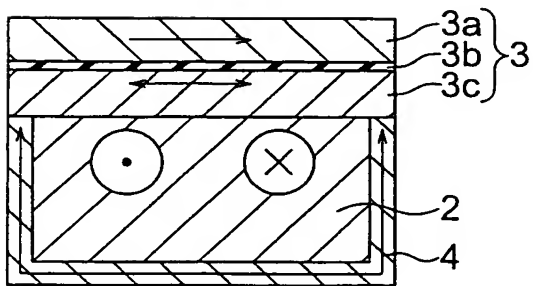


FIG. 7A

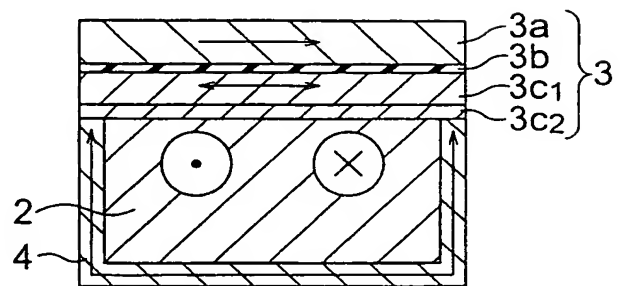


FIG. 7B

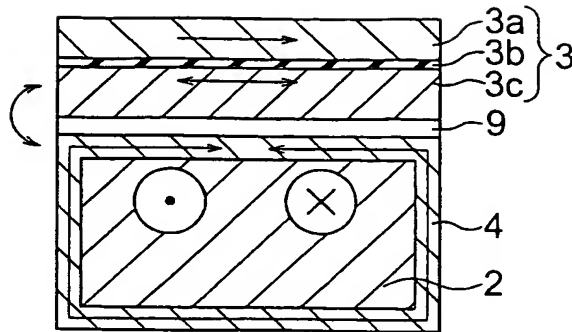


FIG. 8

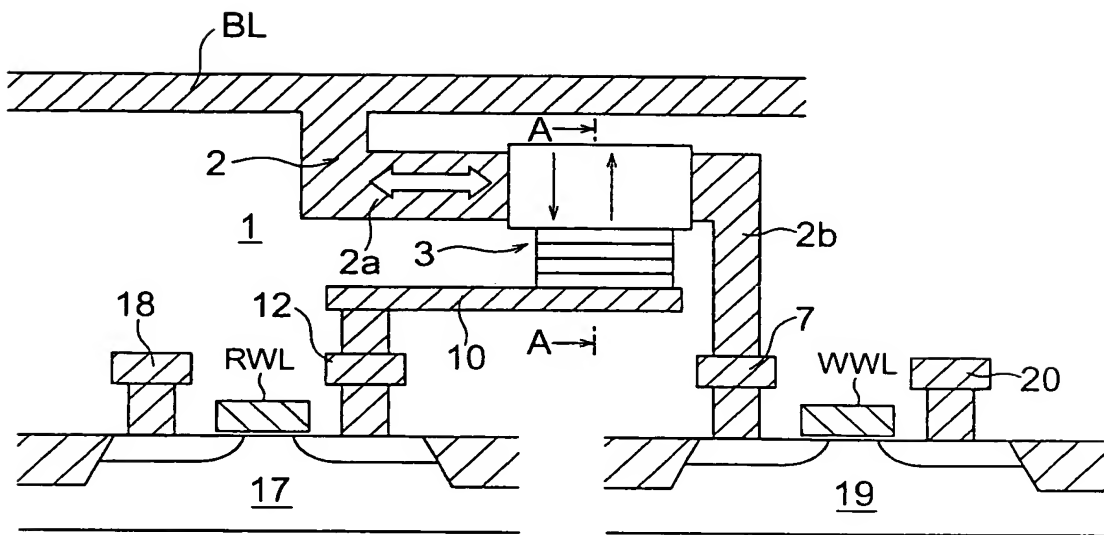
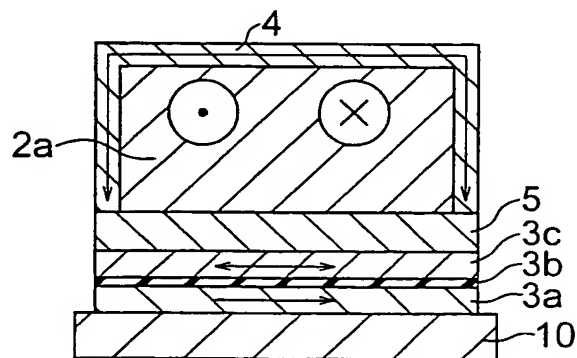


FIG. 9A



A-A SECTION

FIG. 9B

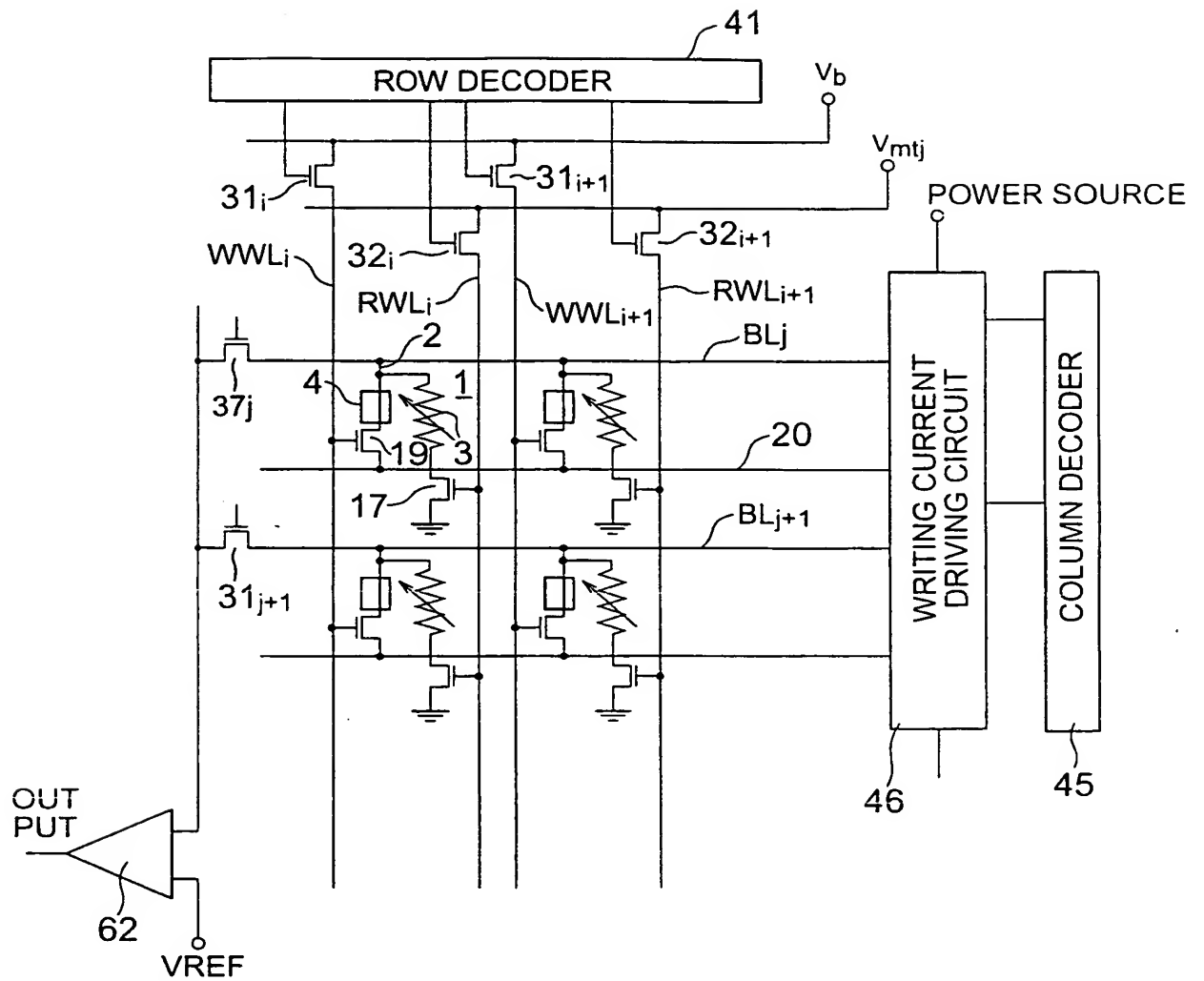


FIG. 10

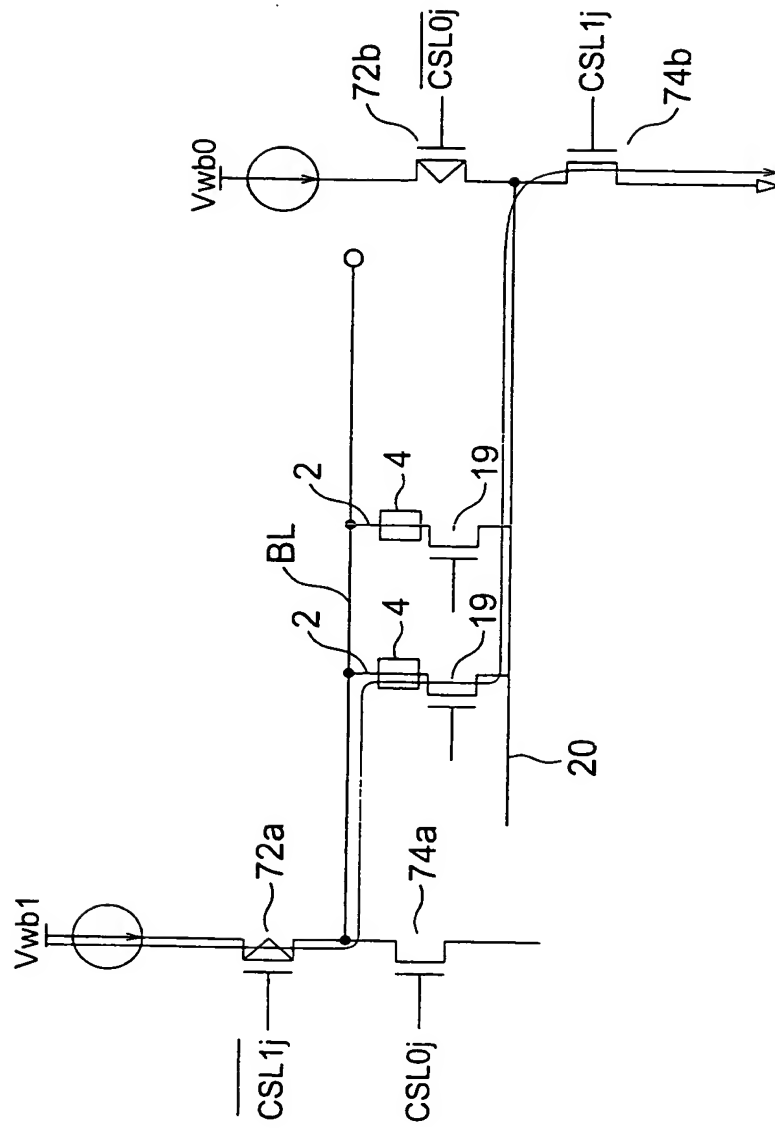


FIG. 11

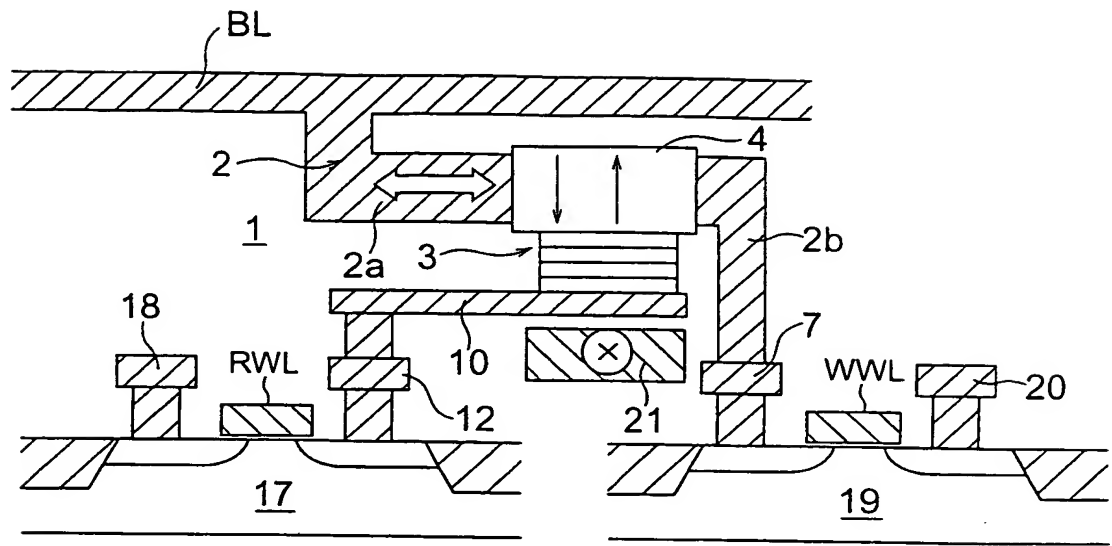


FIG. 12

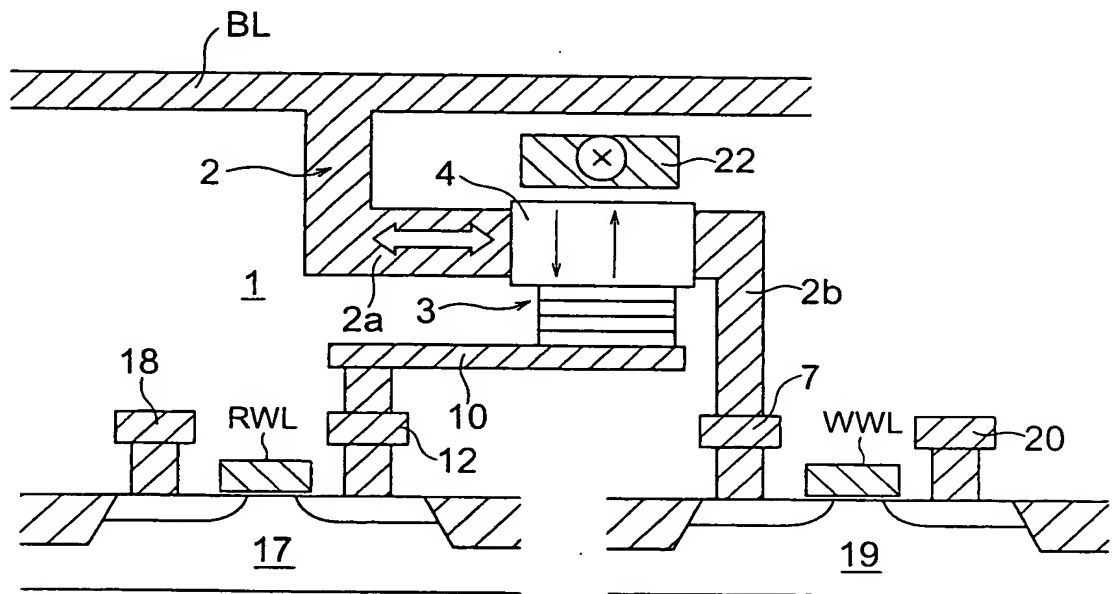


FIG. 13

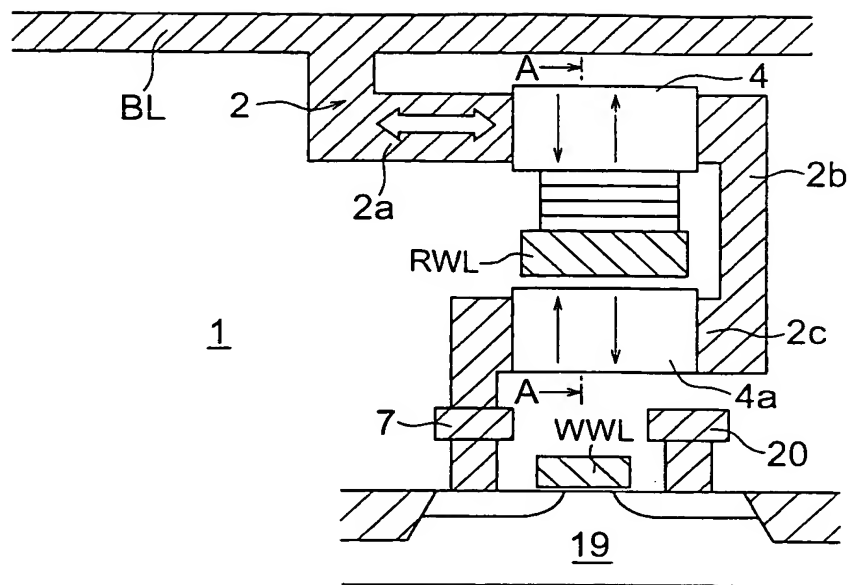
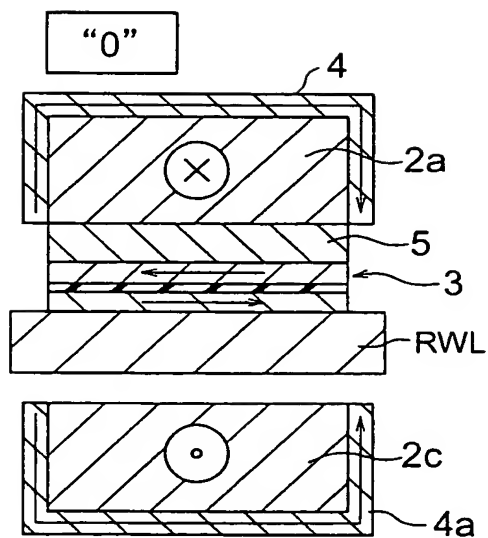
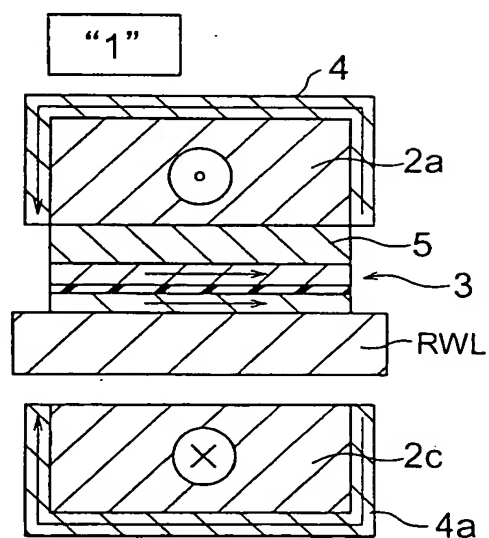


FIG. 15A



A-A SECTION

FIG. 15B



A-A SECTION

FIG. 15C

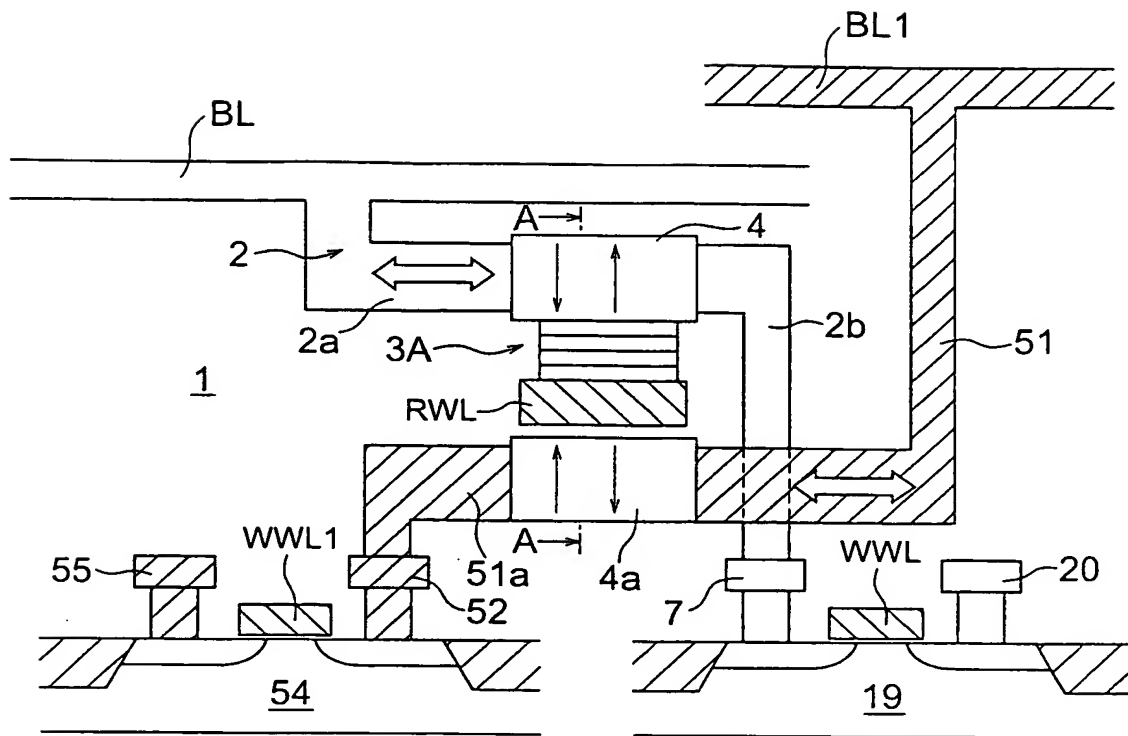
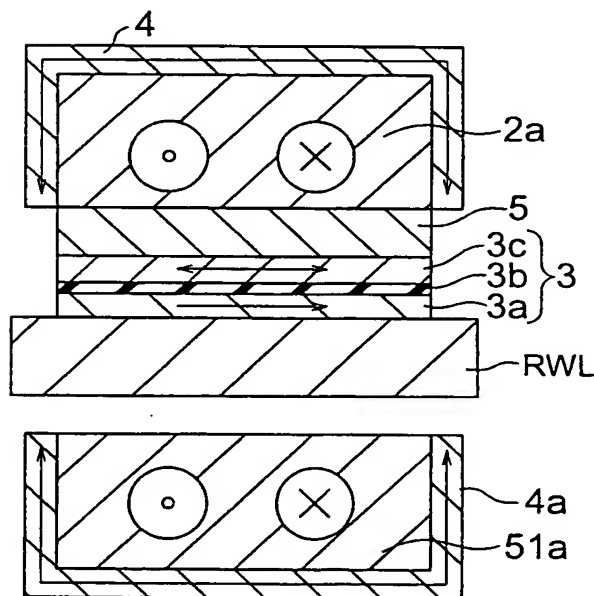


FIG. 16A



A-A SECTION

FIG. 16B

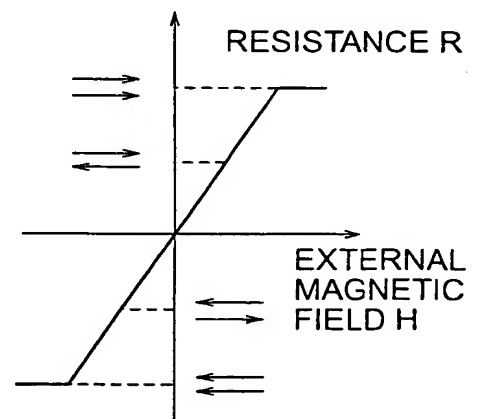


FIG. 16C

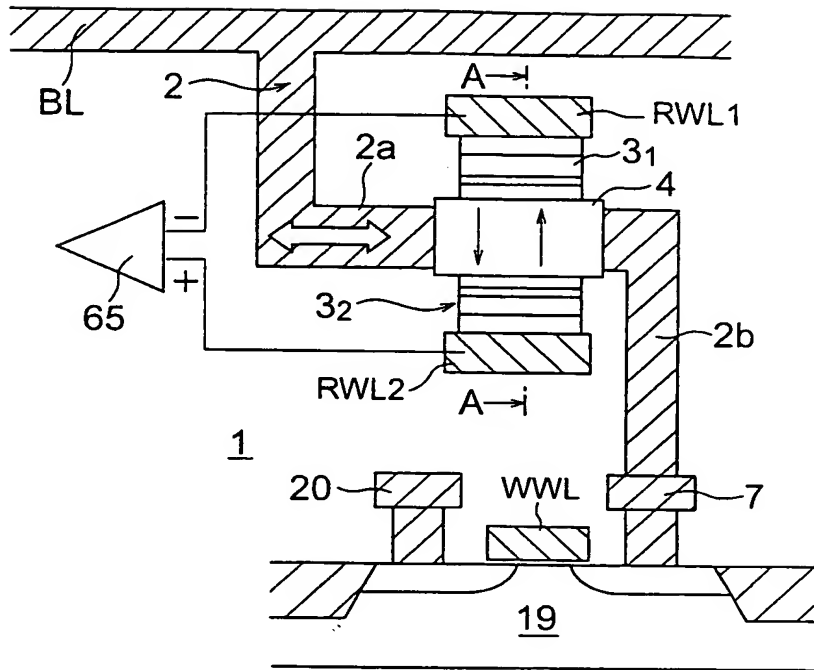
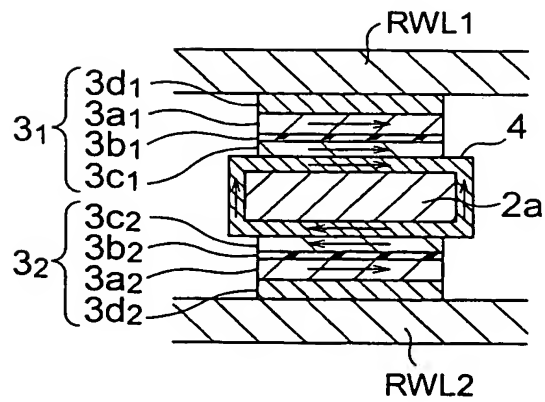


FIG. 17A



A-A SECTION

FIG. 17B

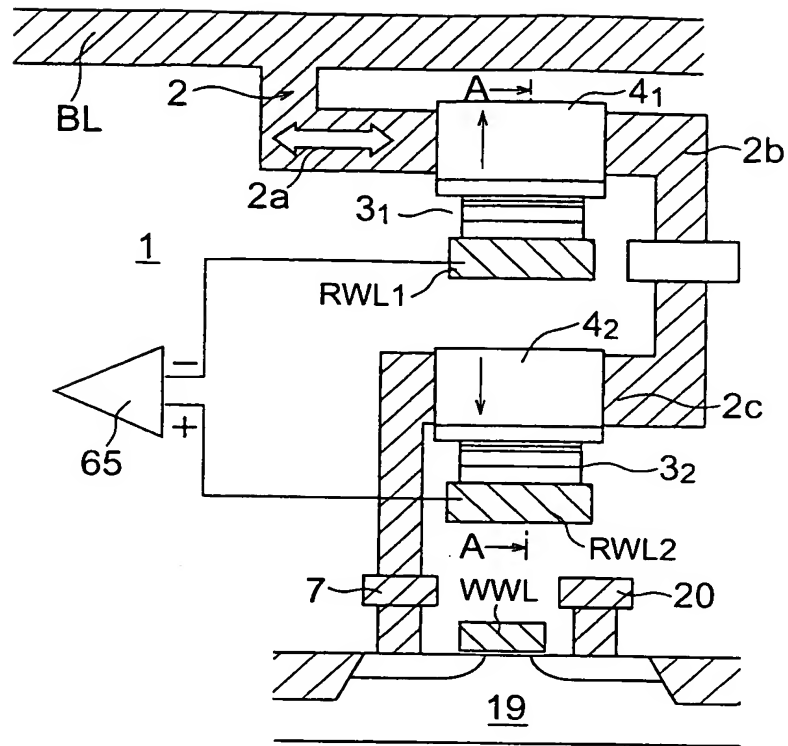


FIG. 18A

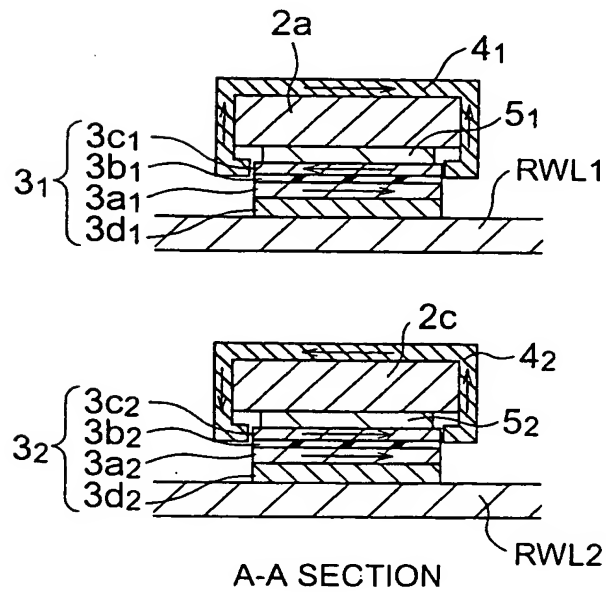


FIG. 18B

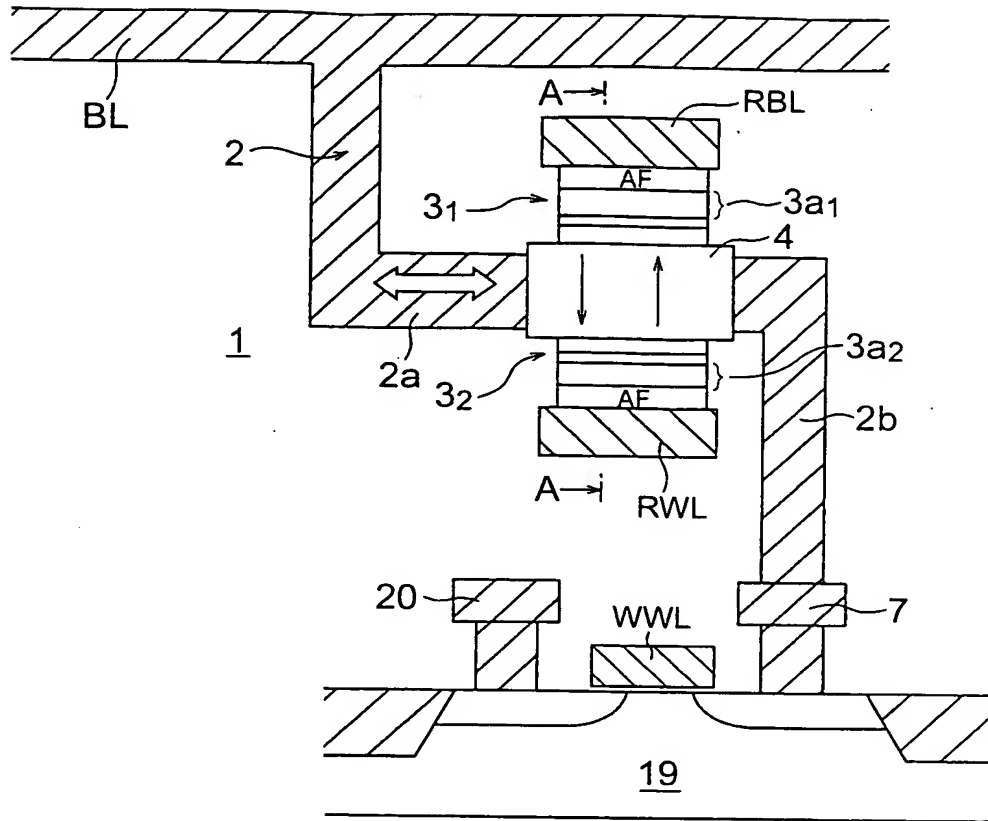


FIG. 19A

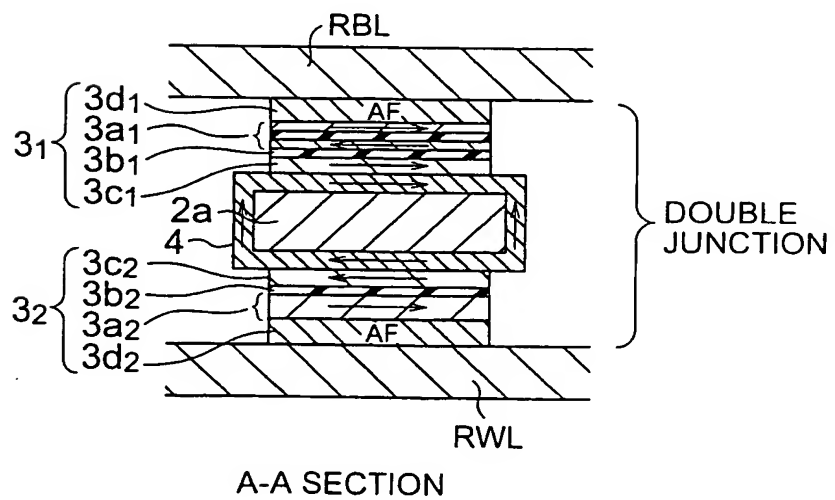


FIG. 19B

A-A SECTION

This diagram shows a cross-section of a semiconductor device with a double junction structure. The top layer is labeled RBL. Below it is a layer labeled AF. The main body of the device is divided into two sections by a vertical line. The left section is labeled 3d1, 3a1, 3b1, and 3c1. The right section is labeled 3c2, 3b2, 3a2, and 3d2. A bracket on the right side of the device is labeled DOUBLE JUNCTION. The bottom layer is labeled 6. The rightmost part of the device is labeled RWL. The label 32 is placed near the bottom left of the device. The label 2a is placed near the bottom center of the device. The label 4 is placed near the bottom center of the device. The label AF is placed near the bottom center of the device. The label RBL is placed near the top center of the device. The label RWL is placed near the bottom right of the device. The label 6 is placed near the bottom center of the device. The label 3d1, 3a1, 3b1, 3c1, 3c2, 3b2, 3a2, 3d2 are placed near the left side of the device. The label 32 is placed near the bottom left of the device. The label 2a is placed near the bottom center of the device. The label 4 is placed near the bottom center of the device. The label AF is placed near the bottom center of the device. The label RBL is placed near the top center of the device. The label RWL is placed near the bottom right of the device. The label 6 is placed near the bottom center of the device. The label DOUBLE JUNCTION is placed on the right side of the device. The label A-A SECTION is placed at the bottom center of the diagram.

FIG. 20B

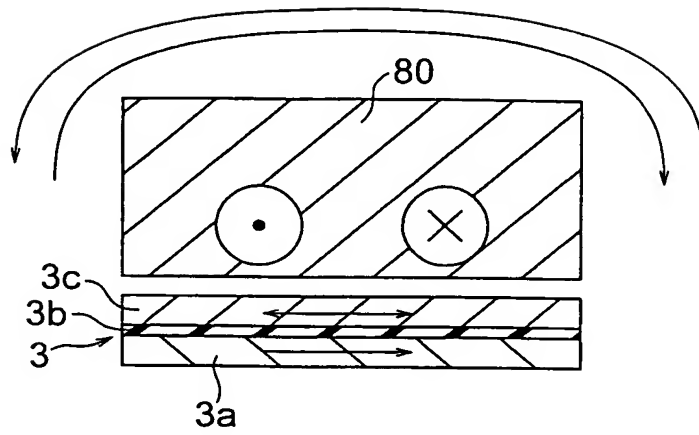


FIG. 21A

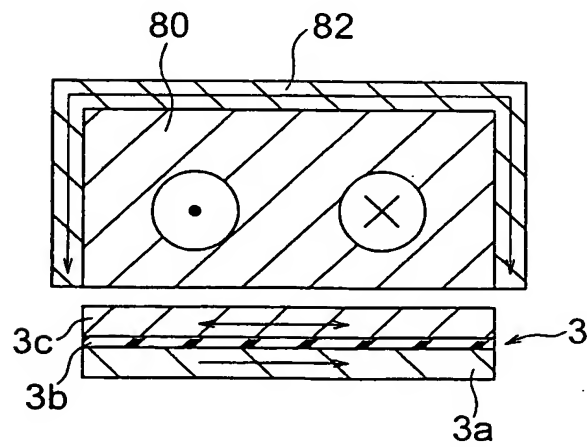


FIG. 21B